Application Note

SigC667x-64 Cards Power and Thermal Evaluation

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1. Introduction

This application report discuss the setup, results and summary of SigC667x-64 accelerator card Power Consumption and Temperature vs. clock rate tests conducted in Signalogic labs. An HP DL-380 Gen8 server is used for the tests, with a SigC667x-64 PCIe card installed with the following specifications:

- 8x 1.25 GHz C6678 8-core CPUs, silicon revision PG2
- 2 GByte of 64-bit DDR3 memory per CPU with 1333 MHz clock rate
- Dual 1 GbE Ethernet interfaces (one interface connected)
- 8x PCIe Gen2 interface

2. Power Consumption Test

2.1 Overview

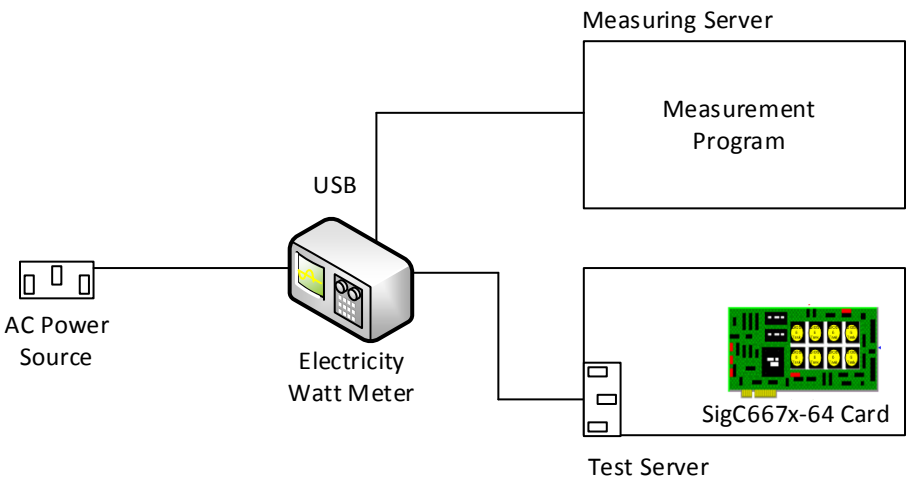

Figure 2.1, Set Up for Power Consumption Test

As the shown in Figure 2.1 above, a single AC power source supply is passed through the power consumption measurement device to the test server.

A video streaming test program is run on C66x CPU cores at 1, 1.4, and 1.6 GHz clock rates. The test program encodes raw YUV data into H264 encoded data and streams it over the network in RTP format. Streams are viewed on tablets to verify integrity and quality (no artifacts). The power consumption measurement device is connected via USB to another Linux server (the Measuring Server) and a Linux utility is used to read power consumption values once per second. The test program is the only process running on the test server.

2.2 Notes

1. Device used: Electricity Watt Meter, Model: "Watts up? PRO"
Device information link: https://www.wattsupmeters.com/secure/products.php?pn=0

2. Quiet State means when test server is ON but the test program is not running and C66x cores are not active.

3. Link to download Linux utility program to measure power consumption:
https://www.wattsupmeters.com/secure/support.php

2.3 Test Results

Power consumption was measured for 2 cores running on 2 CPUs each (total of 4 cores), with the video streaming software configured for 30 fps rate and different resolutions, as shown in Table 2.1 below.

Test Case		**Quiet State**		**Power Consumption vs. Clock Rate (W)**		
30 FPS	CPUs	Card Not Installed	Card Installed	1 GHz	1.4 GHz	1.6 GHz
1280x720p	1 CPU	237	321.34	358	359.6	360.24
	2 CPU			361.9	363.51	365.54
640x480p	1 CPU			356.86	358	359
	2 CPU			359.84	361.54	363.9

Table 2.1, Power Consumption Test Results

2.4 Comparison with TI Power Calculator

Comparison with the Texas Instruments "Power Calculator" spreadsheet (located at http://e2e.ti.com/cfs-file.ashx/__key/communityserver-discussions-components-files/639/3857.C6678_5F00_Power_5F00_Consumption_5F00_Summary_5F00_Rev3_5F00_4.zip) with the following configuration summary (See Addendum A for detailed TI Power Calculator spread sheet settings):

Case temperature: 85 °C (commercial grade)
Frequency: 1 and 1.4 GHz
DDR3 Clock rate: 1333 MHz, 64-bit bus width
PCIe, Timer, MSMC (Multi-Core Shared Memory Controller) peripherals are Enabled

With the above mentioned configuration,

1. For 1 GHz:
Activity Power consumption = 2.8 W
Baseline Power consumption = 4.1 W
Total Power consumed = (Activity + Baseline) power consumption = 6.9 Watt

2. For 1.4 GHz:
Activity Power consumption = 3.9 W
Baseline Power consumption = 10 W
Total Power consumed = (Activity + Baseline) power consumption = 13.9 Watt

TI's power calculator is estimating an increase of 7 Watt per C6678 for clock rate increase from 1 to 1.4 GHz.

2.5 Summary

The above results show a 84.3 W increase over the baseline server with the card installed, and an additional 37 W with 1 CPU (2 cores) active and 1 GHz clock rate. These figures can be considered "floor" or minimum numbers, with additional CPUs and cores increasing power consumption by nominal amounts.

Considering TI's power calculator spreadsheet, the area of interest for comparison purposes is their model's accuracy in estimating the effect of increased clock rate, with all other factors held constant. Using the spreadsheet configuration shown in Addendum A, for 2 active cores, the TI model estimates an increase of 7 W for a clock rate increase of 1 to 1.4 GHz, compared to measured results of about 1 W. For 8-core comparison, extrapolation of measured results would be 8 W vs. 10 W, closer to agreement. It's possible that we need to adjust our settings in the spreadsheet to tune the model.

3. Temperature Measurement Test

3.1 Overview

The purpose of this test was to measure the surface temperature of a C667x CPU as clock rate increases. After removing SigC667x-64 card heat sink, a small hole was drilled in the heat sink exactly above the centre of CPU0. Then, a K-type thermocouple junction was inserted in the hole (between heat sink fins), in contact with CPU0.

Figure 3.1, Location of thermocouple on CPU0, marked in red (note that only the left half section of the card is shown with CPUs 0-3)

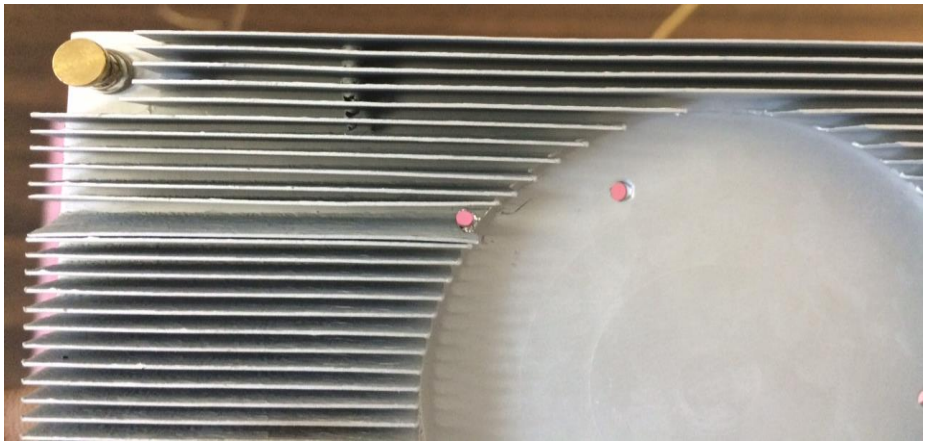

Figure 3.2, Hole drilled into heat sink exactly above centre of CPU0

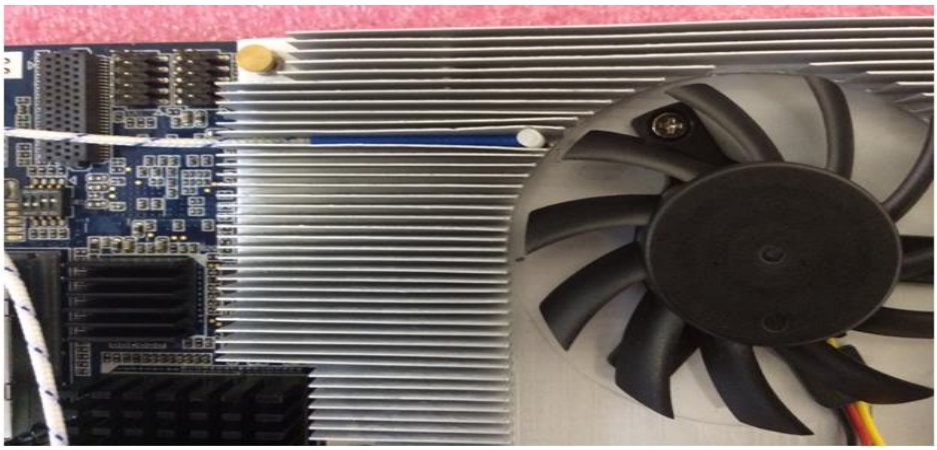

Figure 3.3, Thermocouple passed through heat sink for temperature measurement.
A plastic screw was used to apply downward pressure on the thermocouple for better CPU case contact

3.2 Notes

1. Device used:
EXTECH EasyView 10 Dual input thermometer with K type thermocouple.

2. Procedure to remove heat sink and prepare for thermocouple mounting:

- Unload spring-loaded mounting posts on the heat sink
- Remove side screws from left side metal panel on top surface of the heat sink
- Remove fans
- Provide evenly distributed 170 ^{O}C airflow to heat sink surface until heat paste melts and then ***carefully***, with sideways motion, remove the heat sink from the card. Do not attempt to lift heat sink vertically, which may damage components.

3.3 Test Results

Temperature was measured for a total of 4 C66x cores used by 2 CPUs at different clock rates.

Test Case		**Quiet State**	**Temperature vs. Clock Rate (°C)**		
30 FPS	CPUs		1 GHz	1.4 GHz	1.6 GHz
1280x720p	1 CPU	35.2-35.5	37.5	38.6	39.5-39.6
	2 CPU		37.8-37.9	39.3-39.4	40.5
630x480p	1 CPU		36.1	36.7	37.6
	2 CPU		36.3	37.6	38.3

Table 3.1, Temperature Measurement Test Result

3.4 Summary

The above results show 3 °C increase in surface temperature of CPU0 for clock rate increase of 1 to 1.6 GHz.

4. Next Steps

Test Power Consumption and Temperature Measurements while all 8-cores in SigC667x-64 CPU are being used.

5. Disclaimer

This application report may not contain all of the details necessary to completely set up the test environment. This document is provided as a reference and only intended for information purpose.

All the test results in the application report may vary in test environments other than Signalogic and is provided "AS IS" without warranty or support of any kind and Signalogic expressly disclaims all other warranties, expressed or implied, including, but not limited to, the implied warranties of merchantability for a particular purpose. Under no circumstances shall Signalogic be liable for any incidental, special or consequential damages that result from the use of related document, even if Signalogic has been advised of the liability.

Addendum A - TI's Power Calculator Spreadsheet Settings

TMS320C6678

Silicon Revision	Case Temp (C)	Core Voltage (V)	Variable
2.0	85	Smart Reflex	Power

CorePacs	Frequency	CorePac Status	% SP Util	% CC Util
CorePac 0	1400	ENABLE	100	0
CorePac 1		ENABLE	100	0
CorePac 2		DISABLE	100	0
CorePac 3		DISABLE	100	0
CorePac 4		DISABLE	100	0
CorePac 5		DISABLE	100	0
CorePac 6		DISABLE	100	0
CorePac 7		DISABLE	100	0

Peripherals				%Utilization	%Writes	Bits/Status	%Switching	Units Used
DDR3	666.67			100	50	64	50	
SRIO	3.125	1	DIO	10		Disabled	50	
NetCP			PA+SGMII	20		Disabled	50	
PCIe				100	50	Enabled	50	
HyperLink	7.5			100		Disabled	50	
SPI				100		Disabled		
UART				100		Disabled		
Timer	Max Timers = 16			25		Enabled	# of Timers	8
I2C				100		Disabled		
MSMC				100		Enabled		
Navigator				40		Disabled		
EMIF16				100	0	Disabled	50	
TSIP0				100		Disabled		
TSIP1				100				